MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

PEL0016 – ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

27 FEBRUARY 2017
9:00 A.M. - 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 7 printed pages including physical constants and formula list.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

ANSWER ALL QUESTIONS

QUESTION 1 (15 MARKS)

a) A circular metal ring is suspended above a solenoid. The magnetic field due to the solenoid is shown in **Figure Q1(a)**. The current in the solenoid is increasing.

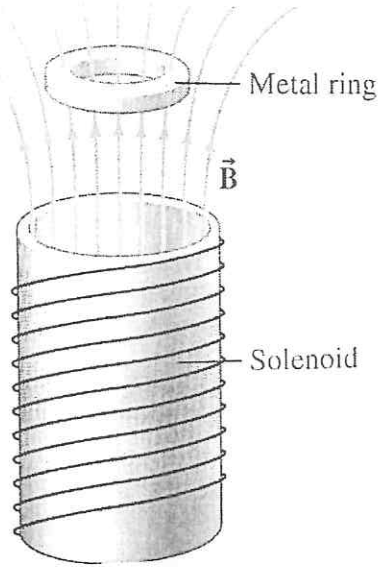

Figure Q1(a)

(i) Determine the direction of the induced current in the ring.

[0.5 marks]

(ii) The magnetic flux through the ring is proportional to the current in the solenoid, $\Phi_B = kI$, where k is the constant of proportionality. When the current in the solenoid is 10.0 A, the magnetic flux through the ring is 0.35 Wb. When the current increases at a rate of 200 A/s, calculate the induced emf in the ring.

[2 marks]

(iii) Is there a net magnetic force on the ring? If so, determine the direction of the net magnetic force.

[1 mark]

(iv) If the ring is cooled by immersing it in liquid nitrogen, what happens to its electrical resistance, the induced current, and the magnetic force? The change in the size of the ring is negligible.

[3 marks]

Continued...

b) Two long insulated wires lie in the same horizontal plane. A current of 20.0 A flows toward the north in Wire A and a current of 10.0 A flows toward the east in Wire B as shown in **Figure Q1(b)**. Calculate the magnitude and direction of the magnetic field at a point that is 5.0 cm above the point where both of the wires cross each other. [6 marks]

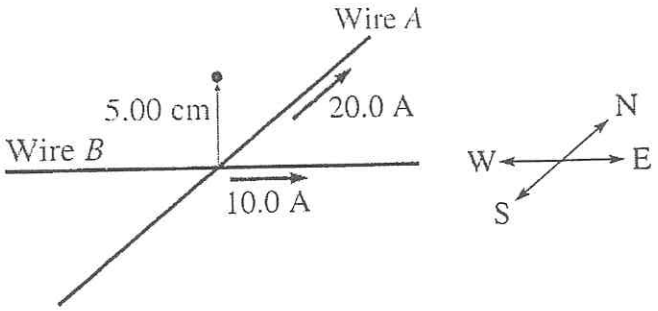

Figure Q1(b)

c) A straight, stiff wire of length 1.0 m and mass 30 g is suspended in a magnetic field B = 0.65 T as shown in **Figure Q1(c)**. The wire is connected to an emf. Calculate the magnitude and direction of current that must flow in the wire so that the wire is suspended and the tension in the supporting wires is zero. [2.5 marks]

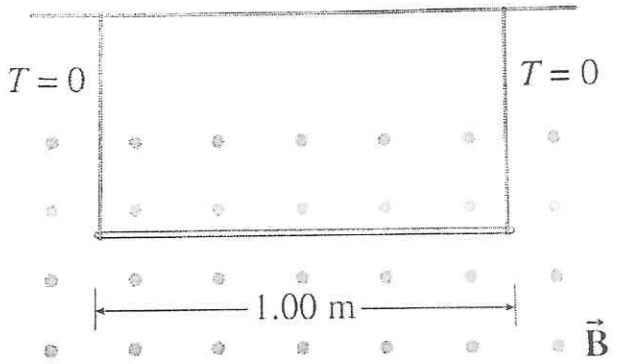

Figure Q1(c)

Continued...

QUESTION 2 (15 MARKS)

a) **Figure Q2(a)** below shows a combination of resistors in a circuit diagram.

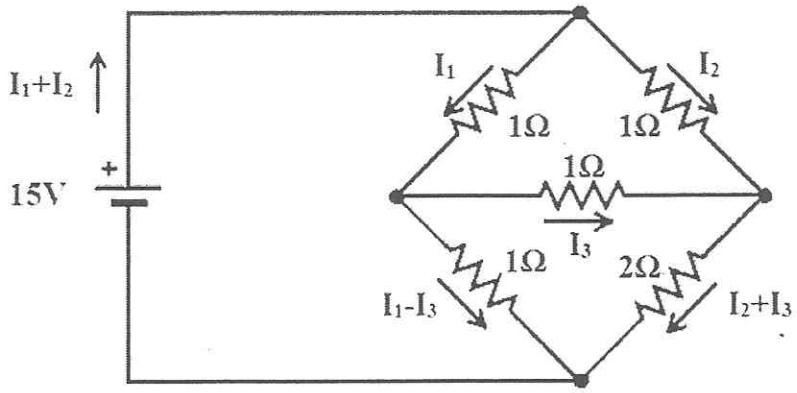

Figure Q2(a)

(i) Calculate current I_1, I_2 and I_3 respectively using Kirchoff's rule.

[8 marks]

(ii) Determine the voltage, V across 2-Ω resistor.

[2 marks]

b) A circuit diagram combining two resistors is shown in **Figure Q2(b)** below:

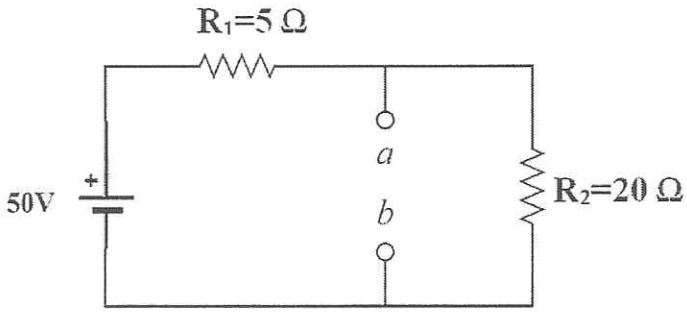

Figure Q2(b)

(i) Find the Thevenin's resistance, R_{TH} and the Thevenin's voltage, V_{TH} as seen from terminal a-b.

[3 marks]

(ii) By using Norton's theorem, calculate the Norton's current, I_N.

[2 mark]

Continued...

QUESTION 3 (10 MARKS)

In an RLC circuit, these three elements are connected in series: a 30.0-Ω resistor, a 45.0-mH inductor, and a 60.0-μF capacitor. The ac source of the circuit has an rms voltage of 200 V and an angular frequency of 1.5×10^3 rad/s. Calculate:

(i) the reactances of the capacitor and inductor, [2 marks]

(ii) the impedence, [1 mark]

(iii) the rms current, [1 mark]

(iv) the current amplitude, [1 mark]

(v) the phase angle, and [1 mark]

(vi) the rms voltages across each of the circuit elements. [3 marks]

(vii) Does the current lead or lag the voltage? [1 mark]

Continued...

QUESTION 4 (10 MARKS)

a) State the difference between intrinsic and extrinsic semiconductor.

[2 marks]

b) With the aid of a diagram, show forward bias of a p-n junction.

[2 marks]

c) Determine I_B, V_B, V_o and V_{CE} in **Figure Q4(c)** for the following values. Given that $\beta_{dc} = 100$ and $V_{BE} = 0.7\ V$.

[6 marks]

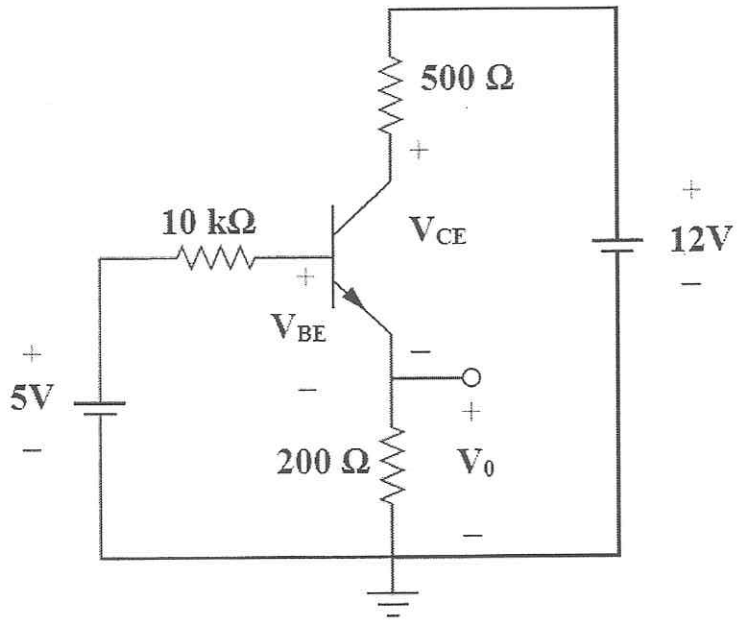

Figure Q4(c)

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APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2 /kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 nI$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$P_t = I_{rms}V_{rms}\cos\phi$$

$$P_r = V_{rms}I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0[1+\alpha(T-T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_O I}{4\pi}\frac{d\ell\times\hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$